ANSWERS TO PROBLEMS

IN

ELEMENTS OF ELECTRICITY

FOR

TECHNICAL STUDENTS

BY

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PREFACE

THE following text contains the answers to the problems as they appear in the "First Edition, Fourteenth Thousand."

In publishing the answers to eight hundred problems, it is practically impossible to put out a text which shall be entirely free from errors. Although the following answers have been checked by at least two teachers, of course some mistakes have crept in, and the author will appreciate it if anyone finding such errors will notify him.

The results were read from a slide rule and may vary by 1 in the last place.

Thanks are due to Mr. F. A. Clark, Pratt Institute, to Mr. F. R. Lufkin, Franklin Union, and to Mr. C. W. Bates, Yale University, for their competent work in checking the results.

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Boston, Mass

ANSWERS TO PROBLEMS

CHAPTER I

1. 3,000,000 lines.
2. 1250 sq.cms.
3. 5000 gausses.
4. 21,600 gausses.
5. 6.67 gausses.
6. 668 unit poles.
7. 2.52 lbs.
8. 3.67 cms.
9. 11.7 unit poles.
10. 222.5 gausses.
11. 55.6 and 88.9 respectively.
12. .1 lb.
16. 285 unit poles.
18. (*a*) 6400 unit poles.
(*b*) 80,500 lines.
19. .23 lb. or 102,400 dynes.
20. 3000 gausses.
21. 80 dynes.
23. (*a*) .0126 lb.
(*b*) 20 gausses; 11.2 gausses.
24. (*a*) .108 lb.
(*b*) 1.58 cms.
(*c*) .108 lb.
25. .644 lb.
26. .322 lb.
27. 6280 lines.
28. 31.3 gausses.
29. 25,000 gausses.
30. 11,900 unit poles.
31. .837 lb.
32. 1600.
33. 12.6 cms.
34. 56,800 gausses.
35. (*a*) 31.3 gausses.
(*b*) 8.94 cms.
36. 13,000,000 lines.

CHAPTER II

1. .264 volt.
2. 4800 ft.
3. .962 ohm.
4. 220 ohms.
5. 20 amps.
6. 2 amps.
7. 5 ohms.
8. 16 volts.
9. 30 volts.
10. 11 ohms.
11. 40 amps.
12. 25 amps.
13. 12 volts.
14. 4 volts.
15. 57.5 ohms.
16. (*a*) .08 amps.
(*b*) 10 volts.
17. (*a*) 204 volts.
(*b*) 203 volts.
18. (*a*) 1.15 amp.
(*b*) 115 volts.
(*c*) 4.60 volts.
19. (1) 32 volts.
(2) 12 volts.
(3) 32 volts.
(4) 972 volts.
20. (*a*) .5 amp.
(*b*) .450 ohms.
21. 1.5 amp.

22. 5 mhos; .2 ohm.
23. 2 and 6 amps. respectively.
24. 17.4 volts.
25. 110 ohms.
26. 100 volts.
27. 15,760 volts.
28. 20 amps.
29. AB and DE 2 amps.
BC and EF .8 amp.
30. 52 volts.
31. 2.05 mhos; .488 ohm.
32. A to B 12 amps.
B to F 8 amps.
B to C 4 amps.
C to E 12 amps.
33. .8 amp; 12 volts.
34. (*a*) 16 volts.
(*b*) 204 volts.
(*c*) 102 ohms.
35. .002 milamp.
36. 93.2; 69.8; 37.2 volts respectively.
4.66 amps.
37. 560 volts.
38. 120 volts.
39. 1 volt.
40. .016 ohm.
41. 3.66 ohms.
42. (*a*) 66 volts.
(*b*) 4.8 volts.
(*c*) 70.8 volts.
43. (*a*) Across CD, 117.5 volts.
" EF, 113 volts.
(*b*) 235 ohms.
(*c*) 226 ohms.
(*d*) 12 volts.
44. (*a*) 110 volts.
(*b*) 1.67 ohms.
45. 2.18 volts.
46. (*a*) Between A and B.
(*b*) Across A, 99 volts.
" B, 87 "
(*c*) 8 volts.
47. (*a*) .734 and 1.10 amps. respectively.
(*b*) .734 and 55 amps. respectively.
(*c*) 60 and 1.97 ohms respectively.
48. (*a*) Through A .281 amp.
" B .234 amp.
" C .512 amp.
(*b*) 54.5 ohms.
(*c*) 214.5 ohms.
(*d*) Across A and B, 28.1 volts.
Across C, 81.9 volts.
49. Current through y, 7.5 amps.
" " z, 10 amps.
Resistance of x, 15 ohms.
Voltage B to C, 37.5 volts.
50. 1596 volts.
1584 volts.
51. (*a*) Across L_1, 110 volts.
" M_2, 114 volts.
(*b*) .200 ohm.
52. (*a*) 2.5 amps.
(*b*) 10 volts.
(*c*) 120 volts.
(*d*) 132.5 volts.
(*e*) 12.5 volts.
53. (*a*) 112.4 volts.
(*b*) 75 ohms.
(*c*) 4 volts.
(*d*) 3.6 volts.
(*e*) Through each lamp of A, 1.16 amps.
Through each lamp of B, 1.50 amps.
54. (*a*) 113.9 volts.
(*b*) 104.5 ohms.
(*c*) 4 volts.
(*d*) 2.09 volts.
(*e*) Through each lamp of A, 1.16 amps.
Through each lamp of B, 1.087 amps.

55. 194.5 volts.
56. (*a*) Across car I, 511.8 volts.
" II, 471.3 volts.
" III, 460 volts.
(*b*) 90 volts.
57. (*a*) Across car I, 533.8 volts.
" II, 516.6 volts.
" III, 511.8 volts.
(*b*) 38.2 volts.

CHAPTER IV

1. 2.43 H.P.
2. 1.81 K.W.
3. 55 watts.
4. 3.03 K.W.
5. 265 watts.
6. 32 watts.
7. 660 watts.
8. 2.20 K.W.
.180 K.W.
9. 135 watts.
10. 62.6 H.P.
11. $1.76.
12. $1.89.
13. .200 K.W. hour.
14. $0.19.
15. 96 K.W. hrs.
16. 1.37 K.W.
17. .455 amp.
18. $0.91.
19. 2.55 K.W. hrs.
20. 5,200,000 ft.-lbs. less.
21. 332,000 cals.
22. .0000139 cents.
23. 2,850,000 cals.
24. 45,700 cals.
25. 293,000 cals.
26. 1.68 hrs.
27. 78.4%.
28. 61 amps.
29. 77.5%.
30. 95%.
31. 93.3%.
32. 92.7%.
33. 91.7%.
34. 92.8%.
35. 91.9%.
36. 91.7%.
37. 94.6%.
38. 3.44 watts per c.p.
39. 33.3 c.p.
40. (*a*) 87.3%.
(*b*) 12.7%.
(*c*) 3.19 watts per c.p.
41. (*a*) .045 ohm.
(*b*) .0009 ohm.
(*c*) .003 ohm.
(*d*) 36,700 amps.
42. .00734 amp.
43. (*a*) 170 volts.
(*b*) 64.7%.
44. 92.3%.
45. 9.9 K.W.
13.3 H.P.
46. 60.5 watts.
47. 162 watts.
48. 88.5%.
49. 90.5 amps.
50. 109 amps.
51. $0.67.
52. $43.90.
53. (*a*) 250 ohms.
(*b*) 62.5 watts; .0838 H.P.
54. 14.7° C. per min.
55. 3.4 mins.
56. (*a*) Across *A*, 117 volts.
" *B*, 114.6 volts.
(*b*) In *CD* and *GM*, 3 volts.
In *DE* and *FG*, 2.4 volts.
(*c*) *A* takes 234 watts.
B takes 343.8 watts.
(*d*) 22.2 watts.
(*e*) 96.3%.
57. (*a*) 125 watts.
(*b*) 77.3%.
.688 watts per c.p.

58. $159.00.
59. 50.8 H.P.
60. (1) 2.5 ohms.
(2) 10.96 volts.
(3) 126 volts
(4) 148 volts
(5) 89.9%.
(6) 166 ohms.
(7) 220 ohms.
61. (*a*) 200 watts.
(*b*) 589 volts; 8.15 amps.
(*c*) 613 volts.
62. $1.50 gain.
63. (*a*) 2.83 ohms.
(*b*) 389 watts.
(*c*) (*S*) 2.79 watts.
(*R*) 142 watts.
(*d*) (1) 62.8%.
(2) .65 watts per c.p.
64. 208° C.

CHAPTER V

1. 26,900 C.M.
2. 4,760,000 C.M.
3. 3910 C.M.
4. .707 in.
5. (*a*) .00307 sq.in.
(*b*) 3070 sq. mils.
6. .667 ohm.
7. 3150 ft.
8. .234 in.
9. 2.04 in.
10. .506 amp.
11. 416 volts.
12. 14 ohms.
13. .314 in.
14. 28.3 sq.in.
15. 5.32 ohms.
16. 262 ohms.
17. 186 ohms.
18. 206 ohms.
19. 38.1° C.
20. 211 ohms.
21. 1.82 ohms.
22. 45° C.
23. 210° C.; .0043 coeff.
24. About No. 3.
25. No. 0.
26. .508 in.
27. 450 ohms.
28. 426 ohms.
29. 10,000 ohms.
30. 8.33 ohms.
31. *BA*, 15.1 cms.
DA, 84.9 cms.
32. 3700 ft.
33. 2220 ft.
34. 3290 ft.
35. 1300 ft.
36. 218 ft.
37. (*a*) 58.9.
(*b*) 1.30 megs.
38. 5.41 volts.
39. 169 volts.
40. 15.0 volts; 272 watts.
41. .483 in.
42. No. 7 (B. & S.).
43. 5071 ft.
44. .152 in.
45. 342,000 C.M.
46. .564 in.
47. 167 amps.
48. .463 ohms.
49. 21.3 volts.
50. 2890 volts.
51. 3470 volts E.M.F.
2820 volts Brush Pot.
52. 77.8% and 79.8%.
53. .00137 milamp.
54. 5.04 megs.
55. 278,000 C.M.
56. (1) *AB*, 340 watts.
CD, 27.6 watts; *FG*, 54.2 watts.
BC, 70.7 watts; *EF*, 22.7 watts.

56. *GH*, 17.7 watts.
(2) (I) 102.7 volts; (II) 101.5 volts; (III) 103.8 volts.
(3) 82.4%.
57. 2.43 ohms.
58. Yes. 40° C rise.
59. 1.71 amps.
60. 40.6 ft. (hard); 43.2 ft. (soft).
61. No. 2.
581 volts.
1.56 K.W., 94.7%.
62. No. 00, 567 volts; 780 watts, 97.2 %.
63. 119.2 volts; 92.2%.
64. 428,000 C.M.
65. 380,000 C.M.
66. 266,000 C.M.
67. In *AB*, .05 amp.
AD, .25 amp.
BD, 0.
BC, .05 amp.
DC, .25 amp.
68. 1,630,000 C.M.
69. 405,000 ohms.

CHAPTER VI

1. 10.08 gausses.
2. 5040 gausses.
3. 12.7 amp. turns per cm.
4. 509 amp. turns.
5. (*a*) 9 gausses
(*b*) 7.16 amp. turns per cm.
6. .143 amp.
7. 71.5 amp. turns.
8. 18,900 gausses.
9. 317 amp. turns.
10. 18,000 gausses.
11. (*a*) 27,000 lines.
(*b*) 2150 unit poles.
12. .922 amp.
13. 40,000 units.
14. 31,800 amp. turns.
15. .00396 units.
16. 6.5 amps.
17. .0188 unit.
18. .0291 unit.
19. 1.20988 units.
20. 597 amp. turns.
21. 12,470 amp. turns.
22. 2.57 amps.
23. 555 amp. turns.
24. 242 turns.
25. 48,000 gausses.
26. 41,100 amp. turns.
27. 101,200 amp. turns.
28. 1.62 amp. (4000 turns).
29. .145 K.W.
30. (*a*) 133 sq.cms.
(*b*) 1720.
(*c*) 557 amp. turns.
(*d*) .000875.
31. 108 volts.
32. 2650 ft.
33. 45.1 volts.
34. 33.5 amp. turns.
35. 14,900 amp. turns.
36. 3.15 amps.
37. .456 amp.
38. 13,500 amp. turns.
39. 1st, 100 sq.cms.; 2nd, 71.4 sq.cms.; 3rd, 133 sq.cms.; 4th, 83.4 sq.cms.
40. .0171 unit.
41. 34,500 amp. turns.
42. .094 unit; 46.3.
43. .0198 unit; 221.
44. 4670 amp. turns.
45. 59,000 amp. turns.
46. .55 K.W.
47. 248 K.W.
48. 7600 amp. turns for the two coils.
49. 2.475 amps.
50. 27.1 watts.

51. 3.5 inches.
52. 4.13 inches.
53. 51° C.

CHAPTER VII

1. 125 volts.
2. .8 volt.
3. 9.6 volts.
4. 150 ft. per sec.
5. (*a*) .198 ohm.
(*b*) .0331 ohm.
(*c*) .0055 ohm.
6. .00614 ohm.
7. 3620 ft.
8. .0081 ohm.
9. 129.73 volts.
10. 960 volts.
11. 98.8 volts.
12. 96.34 volts.
13. 2300 volts.
14. 12.1%.
15. 75 amps.
16. 126.17 volts.
17. 66.2 amps.
18. 12 turns.
19. 66.7 volts.
20. 223 watts.
21. 37.1 watts.
22. (*a*) 6.17 watts.
(*b*) 55.6 volts.
23. .0497 H.P.
24. 334 volts.
25. .349 ohm.
26. 121.5 amps.
27. 291.6 volts.
28. (*a*) 35.5 K.W.
(*b*) 14.5%.
29. 1.296 K.W.
30. 640 volts.
31. 267 R.P.M.
32. 1080 volts.
33. 211 K.W.
34. 2.27%.
35. 640 volts.
36. .155 ohm.
37. 334 volts.
38. (*a*) 0.5 amp.
(*b*) 55 watts.
39. (*a*) 2000 turns.
(*b*) 110 turns.
40. 670 volts.
41. 27,900,000 lines.
42. 1,550,000 lines.
43. 149.4 volts.
44. (*a*) 554 volts.
(*b*) 61 amps.
45. .33 ohm.
46. 25.9 amps.
47. 118.5 volts.
48. 511,000 lines.
49. .0206 ohm; 103.7 amps.
50. 1033 gausses.
51. 1062 gausses.
52. 116.8 volts.
53. 21 amps.
54. 1379 volts.
55. (*a*) 1429 volts.
(*b*) 1424 volts.
56. 504 conductors.
57. (1) 120.4 volts.
(2) 106.34 amps.
58. 120.3 volts; 106.45 amps.
59. .662 ohm.
60. 6 poles.
61. 2,670,000 lines.
62. (*a*) 343.5 amps.
(*b*) 3.51 amps.; 340 amps.
(*c*) 127.4 volts.
63. 120.2 volts; 40.9 K.W.
64. Arm. current, 343.4 amps.
Series field current, 343.4 amps.
Shunt field, 3.44 amps.
E.M.F., 127.4.
Terminal volt, 120.2.
40.9 K.W.
65. 6320 amp. turns.

CHAPTER VIII

1. 12,450 gausses.
2. 15.9 amps.
3. (*b*) Counterclockwise.
(*c*) 3.60 lbs.
4. 4.50 lb. ft.
5. 9.00 lb. ft.
6. .304 lb. ft.
7. Clockwise.
8. .5 ohm.
9. 108.8 volts.
10. 288 amps.
11. 560 amps.
12. (*a*) 7.67 amps.
(*b*) .523 amp.
13. (*a*) 9.00 amps.
(*b*) .512 amp.
14. (*a*) 10.8 amps.
(*b*) .503 amp.
15. (*a*) 13.3 amps.
(*b*) .496 amp.
16. (*a*) 4.00 amps.
(*b*) .494 amp.
17. 112.6 volts.
18. .5 ohm.
19. No turning tendency.
20. 3.2 lbs.
21. 2.66 lb. ft.
22. (*a*) 208 volts.
(*b*) 2.50 K.W.
23. 230 lbs.
24. 1.07 lbs.
25. (*a*) 514 lbs.
(*b*) 321 lb. ft.
26. (*a*) 66.1 H.P.
(*b*) 936 volts.
27. 891 volts.
28. (*a*) 3.00 ohms.
(*b*) .75 ohm.
29. 8.1%
30. (*a*) 55 amps.
(*b*) .55 amp.
31. (*a*) 1 amp.
(*b*) .55 amp.
32. (*a*) 9.94 amps.
(*b*) 3.70 amps.
33. 100 volts.
34. (*a*) Field 1.92 amps.
Arm. 78.1 amps.
(*b*) .466 K.W.
35. (*a*) .500 amp.
(*b*) .496.
36. (*a*) 9.2 K.W.
(*c*) 111.9 volts.
37. (*a*) 92.7 volts.
(*b*) Field, 122 watts.
Arm., 307 watts.
38. (*a*) 72.2 volts.
(*b*) 1.227 K.W.
39. (*a*) Arm., 139.6 amps.
Field, 3.15 amps.
(*b*) 118.4 volts.
40. 772 R.P.M.
41. 1520 R.P.M.
42. 1520 R.P.M.
43. 760 R.P.M.
44. 7.45%.
45. 4.44%.
46. .506 ohm.
47. 7,500,000 lines.
48. 1390 R.P.M.
49. (*a*) 102.4 volts.
(*b*) 118.4 volts.
50. 42 lb. ft.

CHAPTER IX

3. (*a*) 1 K.W.
(*b*) .16 K.W.
4. 110 volt line has four times as heavy wire.
5. No. 5 B. & S.
6. 744 volts.
7. 761 volts.
8. (*a*) $AB = 24$ amps.

8. $EF = 32$ amps.
$CD = 8$ amps.
(*b*) $AB = 7.2$ volts.
$EF = 9.6$ volts.
$CD = 2.4$ volts.
(*c*) 499 watts.
(*d*) $BD = 105.2$ volts.
$DE = 98$ volts.
(*e*) 92%.
(*f*) BD, 4.38 ohms.
DE, 3.06 ohms.

9. Across BD, 120 volts.
" DE, 83.7 volts.

10. Across I, 118.72 volts.
" II, 120.51 volts.

11. 96.4%.

12. Through E_1, 3.185 amps.
" E_2, 1.455 amps.
" line, 4.64 amps.

13. (*a*) 6.67 amps.
(*b*) 3.34 volts.

14. (*a*) line, 11.65 amps.
16.1 amps.
4.45 amps.
(*b*) 116.5 volts.

15. 516.4 watts.

16. 960 watts.

17. 523 watts.

18. 87.7%; 94%.

19. 88.2%; 93.4%.

20. 95.5%.

21. 96.5%; 93.8%.

22. (*a*) 88.4%.
(*b*) 93.1%.

23. 95.2%; 85.8%.

24. 775 watts.

25. (*a*) 9130 watts.
(*b*) 94.8%.

26. Curve.

27. 11,000 volts, No. 9 B. & S.

28. Curve.

29. At 30,000 volts, 21,200 C.M.

30. 1,180,000 C.M.

31. (*a*) 118.8 volts.
(*b*) 96.8%.
(*c*) 95.7%.

32. 100 amp. car, 422 volts.
60 amp. car, 470 volts.

33. 2 cars, nearest gen., 439 volts.
2 cars, furthest from gen., 414 volts.

34. 100 amp. car, 352 volts.
60 amp. car, 401 volts.

35. (*a*) Car I, 536 volts.
Car II, 485.8 volts.
Car III, 464.1 volts.
(*b*) 87.4%.

36. Car I 534 volts.
Car II, 481.3 volts.
Car III, 459.6 volts.

37. 8.3 volts.

38. (*a*) 87.3%; 93.0%.
(*b*) 86.4%.
(*c*) 75.3%.

39. (*a*) 27.4 amps.
(*b*) 106.3 volts.
(*c*) 2.555 volts.

40. 23.62 amps.

41. 11.95 amps.

42. (*a*) 117.95 volts.
(*b*) 119.4 volts.

43. 23.17 amps.

44. 11.8 amps.

45. .948 ohm.

46. 6 parallel rows of 53 cells in series.

47. Input, 7.5 K.W.
Output, 8.53 H.P.
Efficiency, 84.7%.

48. (*a*) MR, 2.8 volts.
RT, 1.2 volts.
OS, .8 volt.
SV, .8 volt.
NW, 4 volts.
(*b*) Across A, 106.4 volts.
" B, 106 volts.

18. Across C, 106 volts.
(*c*) G_1, 1.54 K.W.
G_2, 1.10 K.W.
(*d*) 96.5%.
19. (*a*) MR, 2.33 volts.
RT, 1.00 volt.
SV, 1.32 volts.
NW, 4.65 volts.
(*b*) Across A, 88.4 volts.
" B, 88.7 volts.
" C, 123.3 volts.
(*c*) $G_1+G_2=2.56$ K.W.
(*d*) 96.3%.
20. (*a*) MR, 3.07 volts.
RT, 1.51 volts.
OS, 1.59 volts.
NW, 3.01 volts.
(*b*) Across A, 105.3 volts.
" B, 133 volts.
" C, 79.7 volts.
(*c*) G_1, 1.70 K.W.
G_2, .828 K.W.
(*d*) 96.3%.
21. (*a*) A, 91.7 volts.
B, 91.5 volts.
C, 72.1 volts.
D, 110.4 volts.
22. (*a*) A, 100.3 volts.
B, 99 volts.
C, 77.6 volts.
D, 117.6 volts.
23. (*a*) A, 78.5 volts.
B, 63.6 volts.
C, 19.6 volts.
D, 115.6 volts.
24. 1.193 amps.; 2.39 volts.
25. (*a*) 1.17 amps.
(*b*) 2.33 volts.
26. (*a*) 5.31 H.P.
(*b*) 88.3%; 95.2%.
27. (*a*) I, 127.1 volts.
II, 128 volts.
(*b*) G_1, 129.4 volts.
27. G_2, 133.5 volts.
28. 96.5%.
29. G_1, 92.4%.
G_2, 95.6%.
30. 753 watts.
31. 94.2%; 84.6%.
32. 94.2%; 84.6%.
33. 83.2%; 88.3%.
34. 83.2%; 88.3%.
35. R, .0936 amp.
R_1, .144 amp.
R_2, .110 amp.
R_3, .128 amp.
Gal., .0164 amp.
36. 6,500,000 C.M.
37. 11,140,000 C.M.
38. 3,200,000 C.M.

CHAPTER X

1. 4.11 henrys.
2. 197 volts.
3. .00843 henry.
4. Prim., .705 henry.
Sec., 70.5 henrys.
5. 3.02 henrys.
6. .00021 henry.
7. .336 henry.
8. (*a*) .021 volt.
(*b*) 33.6 volts.
9. 33.6 volts.
10. .371 henry.
11. 740 volts.
12. .400 henry.
13. 32 volts.
14. 550 times.
15. (*a*) .00180 henry.
(*b*) 3.60 henrys.
16. 121 henrys.
17. 1.21 henrys.
18. .0689 amp.
19. 200 volts.
20. 1466 turns.

21. 1430.
22. 4.8 henrys.
23. 31.7 henrys.
24. Prim., 317 henrys.
Sec., 3.17 henrys.
25. .035 amp.
26. 110 volts.
27. .734 henry.
28. 384 henrys.
29. 188 turns.
30. 4320 volts.

CHAPTER XI

1. 10.9 mfs.
2. 642 volts.
3. .0044 coulomb.
4. .0275 amp.
5. .055 amp.
6. 1510 watts.
7. .484 watt-secs.
8. .00032 secs.
9. 6.88 amp; 755 watts; .484 watt-secs.
10. 20 amps.; 6420 watts; 2.25 watt-secs.
11. .00035 secs.
12. (*a*) .121 watt-sec.
(*b*) .484 watt-sec.
13. 1.59 mfs.
14. .000319 coulcomb.
15. .465 mf. ($K=2.5$).
16. 8.05 mfs. ($K=2.5$).
17. .0084 mf.
18. .179 mf.
19. .534 mf.
22. 1170 ft.
23. 1.32 mfs.
24. .00066 coulomb.
25. (*a*) .00044 coulomb.
(*b*) .0011 coulomb.
26. .000157 coulomb.
27. $E_1=30$ volts.
27. $E_2=80$ volts.
28. 2.79 mfs. ($K=2.1$).
29. 7.98 mfs.
30. 10.77 mfs.
31. 2.07 mfs.
32. .00119 coulomb.
33. .00414 amp.
34. 2600 ft.
35. 4 in series with 1 and 3 in parallel.
2 mfs.
36. 0.0254 watt-sec.
37. .000042 sec.
38. .000277 sec.
39. .000035 sec.
40. 176 volts.
41. 330 volts.
42. 10 mfs. has .00176 coulomb.
15 mfs. " .00264 "
43. .00198 coulomb.

CHAPTER XII

1. 148 gms.
2. 46.7 hrs.
3. 19.2 amps.
4. 255 hrs.
5. 71.9 hrs. and 77.9 hrs.
6. 1.17 amp.
7. 1.15% high.
8. .914 oz.
9. (*a*) 27.3 amps.
(*b*) 219 amp. hrs.
10. (*a*) 1.54 sq.ft.
(*b*) 80 amp. hrs.
11. 2.31 sq.ft.
12. .0267.
13. 2.64 volts.
14. .16 volt.
15. Charge, 2.32 volts.
Discharge, 2.08 volts.
16. .325 ohm.
17 7 end cells.

18. 56 cells.
19. .988 ohm.
20. 6 cells.
21. 1.5 mi.
22. More than 13.3 amps.
23. 153 hrs.
24. 65.6 hrs.
25. .000138 in.
26. Zinc, $0.134 per K.W. hr.
Coal, $0.010 per K.W.hr.
27. 4.97 ohms.
28. 3.36 ohms.
29. 91.28 volts.
30. 169.4 volts.
31. 92.37 volts.
32. 4.81 ohms.
33. .77 ohm.
34. 1368 R.P.M.
35. (*a*) 104 amp. hrs.
(*b*) 4.44 K.W. hrs.
36. (*a*) 218 amp. hrs.
(*b*) 36.8 K.W. hrs.
37. 2 parallel sets of 45 in series.
38. (*a*) 6 parallel sets of 15 in series.
(*b*) 31.8 volts.
39. .0075 ohm.
40. 103.5 amps.
41. 479 volts.
42. 82.2 amps.
43. 314 amps.
44. Delivering 11 amps.
45. (*a*) 189.3 amps.
(*b*) Receiving 39.3 amps.

CHAPTER XIII

1. (*a*) 1.28 ft. candles.
(*b*) 3.54 ft.
2. (*a*) 2.82 ft.
2. (*b*) 4 ft.
3. 7.55 ft.
4. 3.9×10^{16} c.p.
6. 18.9 c.p.
7. $A=4x$.
8. 15.6 c.p.
9. 3.8 watts per c.p.
10. 67% longer.
11. 52% of normal life; 18.5 c.p.
2.92 watts per c.p.
12. 27.8 c.p.
13. 1.03 ft. candle.
14. 980 c.p.
15. .05 ft. candle.
16. 150 cms.
16*a*. $AE=29.8$ c.p.
$BF=27.8$ c.p.
17. 11.3 c.p.
18. .5 ft. candle.
19. .36 ft. candle.
20. .311 ft. candle.
21. .306 ft. candle.
22. (1) .526 ft. candle.
(2) .142 ft. candle.
(3) .306 ft. candle.
(4) .320 ft. candle.
23. (5) .202 ft. candle.
(6) .106 ft. candle.
(7) .152 ft. candle.
(6) .504 ft. candle.

CHAPTER XIV

1. 1–11.
2. 111.1 ohms.
3. 562 divisions.
4. 51.1 ohms.
5. .0101 ohms.
6. .484 amp. or 8.8% low.
7. .185 amp. low.
8. 1.928 amps. low.
9. 14,995 ohms.
10. .000333 ohm.
11. 20,000 ohms.
12. 5.1 volts low.
13. .2 volt low.

14. (*a*) 3.75°.
(*b*) 60°.
(*c*) 113.5°.
15. (*a*) 1.63 amps.
(*b*) 3.27 amps.
(*c*) 4.47 amps.
16. 1.48% high.
17. (*a*) .458 amp.; 112 volts.
(*b*) .04 of 1% high.
18. 60.5 watts.
19. 60.5 watts; 110 volts; .634 amp.
20. 1.4283 volts.
21. 28.566.

CHAPTER XV

1. 1090 volts.
2. −410 volts.
3. 414 volts.
4. 308 volts.
6. 20° = 205 volts.
80° = 591 volts.
130° = 460 volts.
210° = −300 volts.
300° = −520 volts.
340° = −205 volts.
7. 12,580 volts.
8. 10,900 volts.
9. 38,400 volts.
10. 60,400 volts.
11. 42,700 volts. No.
12. 15.4 amps.
13. 15.4 amps.
14. 180° = 0 amp.
200° = −5.27 amps.
300° = −13.3 amps.
15. 35.4 amps.
16. 22.5 amps.
17. 142 amps.
18. 707 volts.
19. 8880 volts.
20. 42,700 volts.
21. 6.25 amps.
22. 6.94 amps.
23. 6.00 amps.
24. 37.5°.
25. −34.2 amps.
26. (*a*) 320 volts.
(*b*) 355 volts.
(*c*) 503 volts.
27. (*a*) 22.5°; (*b*) 192 volts.
28. 141 volts; 45 amps.
29. (*a*) 38.8 amps.
(*b*) 27.5 amps.
30. (*a*) 779 volts.
(*b*) 495 volts.
31. 14° lag.
32. 108 amps.
33. −32.2 amps.
34. 68.4 volts.
35. (*a*) 27.8 amps.
(*b*) 726 volts.
36. 12.35 ohms.
37. 111°.
38. 113 volts.
39. 0.
40. 62.7 amps.
41. 41 amps., 44 volts.
42. 55 ohms.
43. 1.8 amps.
44. 707 volts.
45. (*a*) −968 volts.
(*b*) 284.4°.
46. 3.65 amps.
47. 29° current; 119° voltage; 136 volts.
48. 29.2 cycles per sec.
49. 36.7 ohms.
50. .0165 henry.
51. 43.4 amps.
52. .73 amp.
53. 7.25 amps.
54. −488 volts.
55. 162 volts.
56. .738 amp.
57. 17.1 amps. ($K = 1.86$).

58. 17.6 amps.
59. 3280 ohms.
60. .168 amp.
61. .34 amp.
62. 1.34 amps.
63. −.416 amp.
64. .953 amp.
65. 60.2 ohms.
66. 9.14 amps.
67. 37 ohms.
68. 4.19 amps.
69. 96.3 ohms.
70. 1.14 amps.
71. 8.59 amps.
72. Across reactance, 171.8 volts.
" R, 137.4 volts.
73. Current leads voltage 51.3°.
74. (*a*) 20.5 amps.
(*b*) (1) 287 volts.
(2) 410 volts.
(3) 246 volts.
(4) 205 volts.
(5) 82 volts.
(*c*) Current leads 26.6°.
75. (*a*) Across $X_L = 32$ volts.
" $X_C = 8$ volts.
(*b*) Across combin. = 31.2 volts.
(*c*) Current lags 50° 20′.
76. 41.8 amps.
77. Current lags 62.9°.
78. .523 amp.
79. Current leads 41°.
80. 1.04 amps.
81. 2.22 amps.; current lags 57.5°.
82. Through AB, 1.29 amps.
" CD, 3.45 amps.
" FG, 3.69 amps.
Current in FG lags 10 min.
83. 1.358 K.W.
84. .98.
85. 2.32 K.W.
86. 2.14 amps.
87. (*a*) 11 amps.
(*b*) 1.21 K.W.
88. 1.45 amps.
89. 21 watts.
90. (*a*) 65%.
(*b*) 2.55 K.W.
91. 90.9%; 24.7°.
92. 87 volts.
93. 15.5 amps.
94. 17.2 amps.
95. (*a*) 5° lag.
(*b*) 99.6%.
(*c*) 1.22 K.W.
(*d*) 1.63 K.W.
96. (*a*) 143 volts.
(*b*) 107.5 volts.
(*c*) −132 volts.
97. $i = 189 \sin \phi$.
98. (*a*) 108 amperes.
(*b*) −90.6 amperes.
99. (*a*) 161 volts.
(*b*) 279 volts.
(*c*) 96 volts.
100. (*a*) 420 volts.
(*b*) −34.2 volts.
(*c*) 431 volts.
101. (*a*) 59.5 amps.
(*b*) 11.1° lag.
102. (*a*) 4.53 K.W.
(*b*) 2.02 K.W.
(*c*) 6.55 K.W.
103. I branch, 6.03 K.W.
I_1 " 1.40 K.W.
104. 200 volts.
105. (*a*) 5000 watts.
(*b*) 25 amps.
106. 200 volts.
107. $i = 35.3 \sin \phi$; $e = 282 \sin \phi$.
$e = 282 \sin \phi$; $i = 35.3 \sin (\phi - 90°)$.
108. (*a*) 200 volts.
(*b*) $e = 282 \sin \phi$; $i = 35.3 \sin (\phi + 90°)$.

109. 1.46 amps.
110. (*a*) 1.43 amps.
(*b*) 78.8°.
111. (*a*) $e=156 \sin \phi$; $i=2.02 \sin (\phi-78.8°)$.
(*b*) 30.7 watts.
112. $e=156 \sin \phi$; $i=2.07 \sin (\phi-90°)$.
None.
113. 3.16 amps.
64.5°.
$e=156 \sin \phi$; $i=4.47 \sin (\phi-64.5°)$.
150 watts.
114. 7.33 amps.
805 watts.
115. −1.98 amps.
116. $e=640 \sin (\phi+51.4°)$.
117. (*a*) 500 volts.
(*b*) 1000 watts.
118. 594 volts across combination.
589 volts across X.
75 volts across R.
119. 196 amps.
197.6 amps.
120. 68.8 volts.
121. .182 amps.
122. 881 volts.
123. 98.3 K.W.
124. .999985; 98.3%
125. $R=4.89$ ohms.
$X_L=3.03$ ohms.
$Z=5.75$ ohms.
126. (*a*) 58.5 volts.
(*b*) 147 volts.
(*c*) 51.7 volts.
(*d*) 4.89 amps.
127. (*a*) .523.
(*b*) By $R=286$ watts.
$X_L=0$ watts.
$X_C=0$ watts.
128. (*a*) 2.3 amps.
(*b*) 77.3 volts; 32.2.
(*c*) 4.7° lag.
129. (*a*) 3.28 amps.; 7.9 amps.
(*b*) 110 volts.
(*c*) In pl ase.
130. 143 volts.
131. (*a*) 32.86 volts.
(*b*) 77.5%.
132. 862 watts.
133. 489 mfs.
134. 10.9 ohms.
135. 113 amps.
136. 96%.
137. 56.4 amps.
138. 28.2 amps.
139. (*a*) 500 amps.
(*b*) 866 amps.
(*c*) 500 amps.
140. 173 volts.